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硕　士　学　位　论　文

船舶溢油风险评价在港湾区域环境规划中的应用

Application of Risk Assessment of Oil Spill from ships to the Regional Environmental Planning

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摘要

海洋环境是人类赖以生存和发展的自然环境的重要组成部分，保护海洋环境，对海岸地区的可持续发展至关重要。随着海上石油运输量日益增长，船舶溢油事故不断发生，并已成为造成海洋环境污染的主要因素之一。频繁发生的船舶溢油事故严重危害海洋生态系统，使当地渔业、水产养殖业、旅游业等蒙受惨重的经济损失，对经济发展与海洋环境保护极为不利。因而，进行船舶溢油事故风险评价及风险防范措施的研究，尤其是在港湾区域环境规划阶段就开展这方面的工作，将有助于更好地进行港湾船舶溢油风险管理与决策，有效地规避因决策失误而带来的环境风险，不仅具有学术价值，而且具有重要的现实意义。

本论文基于环境科学、环境规划学、环境评价学和环境管理学等多学科的理论，采用文献查询、资料收集、理论分析、模型构建和案例研究相结合的手段，建立了港湾区域环境规划中的船舶溢油风险评价框架与方法体系，并将该评价框架与方法体系应用于环罗源湾区域的案例研究中。论文的主要研究成果如下：

（1）通过对现有的区域环境规划的总结与分析发现，环境风险评价在区域环境规划体系中的理论与实例研究均罕见。本论文阐述了将环境风险评价纳入区域环境规划的必要性和重要性，提出应当考虑将环境风险评价纳入区域环境规划的体系，并结合港湾区域的环境特点，构建了一个包含船舶溢油风险评价的港湾区域环境规划的框架。

（2）基于国内外相关研究进展的总结与分析，构建了一个适用于港湾区域环境规划的船舶溢油风险评价框架，该框架主要包括港湾区域船舶溢油事故的风险识别、船舶溢油风险的预测与评价和船舶溢油风险管理与防范措施等。同时，采用数理统计、数值模拟和计算机辅助等方法，建立了船舶溢油风险的评估模型，形成适合于港湾区域环境规划的船舶溢油风险评价的方法体系。

（3）将所建立的船舶溢油风险评价的框架和方法体系，应用于环罗源湾区域的案例研究，预测与评价罗源湾船舶溢油风险。预测与评价的结果显示：随着罗源湾港口航运业的快速发展，罗源湾海域存在着不可忽视的船舶溢油风险。基于罗源湾远期船舶数量预测，罗源湾海域船舶溢油概率为 0.0925，约为每 10 年 1 次。随着进出港船舶数量的增加，油轮比例的增大，溢油的风险概率将随之上升。根据各吨级溢油量的发生概率，推算出罗源湾船舶事故每次可能产生的溢油

量为 57.3 吨原油，即 67.41m^3，经过一个潮周期，油膜面积理论估算值为 0.64km^2。溢油事故将给罗源湾的生态环境带来严重的后果，尤其将影响到湾内的水产养殖业。本论文从船舶交通管理系统和相关制度的建设与完善、改善通航条件、提高从业人员素质和加强对进出港船舶的监督管理等方面入手,制定了相应的风险防范措施，同时探讨了罗源湾船舶溢油事故应急计划的制定等相关问题。罗源湾船舶溢油风险评价为环罗源湾环境保护规划的制订提供了科学依据。

关键词：溢油；风险评价；风险防范

Abstract

Marine environment is an indispensable part of the natural habitat for mankind existence and development. It is crucial to protect the marine environment for the sustainable development of coastal zones. With the increase of oil transportation volumes by sea, the frequent occurrence of oil spill from ship has become one of the major factors responsible for the marine environment pollution. Detrimental to the marine ecological system, those oil spill accidents has brought disastrous economic losses to the local fishery, aquaculture and tourism and put economic development and marine environmental protection in an unfavorable position. Therefore, it bears both the academic and practical significance to study risk assessment of oil spill from ships and preventive measures, especially at the stage of the regional environmental planning, to assist the risk management and decision making of oil spill from ships and to effectively avoid the environmental risk resulting from wrong decisions.

On the basis of theories from disciplines like environmental science, environmental planning, environmental assessment and environmental management, this thesis establishes a risk assessment framework and method system for oil spill from ships in the regional environmental planning to the bay and the surrounding areas with a combination of literature review, data collection, theoretical analysis, model construction and case study methods. The assessment framework and method system are applied to the case study on Luoyuan Bay. The major findings of the thesis are listed below:

(1) Literature review and analysis on the current regional environment planning reveal that there are rare theories and case studies available on environmental risk assessment (ERA) from the aspect of regional environmental planning system. By elaborating the necessity and significance of including ERA into regional environmental planning, this thesis advances that ERA should be brought into regional environmental planning system. Furthermore, a framework of the regional environmental planning to the bay and the surrounding areas, comprising the risk assessment of oil spill from ships, is put forward according to the coastal

environmental characteristics.

(2) On the basis of relevant studies at home and abroad, the thesis constructs a framework of the risk assessment of oil spill from ships applicable to the regional environmental planning to the bay and the surrounding areas. The framework mainly includes the risk identification of oil spill from ships accident, the prediction and assessment of such risk, risk management and preventive measures. Meanwhile, the assessment model of oil spill from ships is established through mathematical statistics, numerical simulation and computer assisted methods to form a method system suitable for the regional environmental planning to the bay and the surrounding areas.

(3) The framework and method system is applied to the case study on Luoyuan Bay, predicting and analyzing the risk of oil spill from Luoyuan Bay. The results indicate that with the rapid development of harbor transportation, there are risks of oil spill that cannot be overlooked in Luoyuan Bay. According to the predicted number of ships in and out of Luoyuan Bay in the future, the probability of oil spill from ships is 0.0925, about once each ten years. As the number of ships in the harbor increases, especially the number of oil tankers, the probability of oil spill also increases. By calculation of the probability of oil tankers in different tonnages, it is inferred that the possible quantity at one time would be 57.3 tons ($67.41m^3$) and the oil diffusion area would become $0.64km^2$ after one tidal cycle. Oil spill accident may have a severe effect on the ecological environment, especially on the aquaculture within the bay. The thesis puts forward some relevant measures for the risk prevention of oil spill in Luoyuan Bay from several aspects such as the improvement of ship transportation manage system and regulation, channel navigation condition, the quality of crew member and supervision of ships in and out of the harbors. The thesis discusses problems relating to the formation of oil contingency plan in Luoyuan Bay at the same time. The risk assessment of Luoyuan Bay provides scientific support for the formulation of Luoyuan Bay environmental protection planning in the future.

Keywords: oil spill; risk assessment; risk prevention

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